Remarks

This Response is filed in response to the Advisory Action dated April 8, 2008 and assumes entry of the Response dated March 19, 2008 into the official file. This Response is filed together with a Request for Continued Examination.

All of the pending claims have been cancelled, thereby rendering the extant rejections moot. The Applicants have added new Claims 23-30. New Claim 23 is a combination of the subject matter of Claims 1, 5-7 and 9. New Claim 24 corresponds to the compositional elements found in original Claim 2. New Claims 25 and 26 are similar to original Claims 10 and 11, combined. New Claims 27 and 28 correspond to original Claims 13 and 14, respectively. New Claims 29 and 30 correspond to original Claims 15 and 16, respectively. Entry into the official file and consideration on the merits is respectively requested.

Fundamentally, the previously cited references do not disclose, teach or suggest that a heating temperature of the final induction hardening is 800-950°C. The Applicants respectfully submit that US '105 only discloses (a) carburization hardening at 930-950°C (Example 1, Table 2) and (b) quenching after an hour of reheating of carburized steel at 900°C. There are very important differences between the two.

The Applicants enclose Doc. 1 which is a definition of induction hardening in the glossary of "Metals Handbook, Desk Edition," issued by the American Society for Metals. Induction hardening is a method in which only the surface layer of a steel product is heated by electromagnetic induction before quenching. Therefore, heating is conducted quickly and done in seconds. This is seen on page 20, lines 6 to 9 (5 seconds or less) in the Applicants' disclosure and in paragraph [0017] (4 seconds) of translated JP '937.

In sharp contrast, in carburization hardening, carburization is conducted while heating under high carbon potential (see Example 5, items I to III). To ensure carburization, heating takes a long time and is measured in hours. See Example 1 (5 hours) and Example 5 (1 to 12 hours). Thus, even under such an extended long-time heating pre-existing austenite grain size is relatively small because the high carbon content and/or large amount of carbon precipitates suppresses coarsening of the austenite grains during heating when appropriately carburized.

To the contrary, in induction hardening, such a coarsening suppression factor (*i.e.*, high content of carbon or carbon precipitate) does not exist. Therefore, coarsening of the austenite grains

tends to quickly occur and the microstructure before induction heating and chemical composition of the steel product as well as the heating conditions are significant factors in controlling the size of the austenite grain during heating of induction hardening.

In other words, major factors for controlling the pre-existing austenite grain size are very different between carburization hardening and induction heating. Therefore, conditions such as the temperature of carburization hardening shown in disclosure (a) in US '105 does not provide any suggestion of the temperature of induction heating.

Regarding disclosure (b) in US '105, the carbon content of the surface of the steel which is re-heated before quenching is conducted is inferred as 1.15 to 1.2%, which is the carbon potential in the previous carburization. Therefore, a significant factor to control the pre-existing austenite grain size is still a high content of carbon or carbon precipitate. Re-heating is conducted in one hour (a note in Table 8). Again, the temperature in such heat treatment does not provide any suggestion of the temperature of induction heating.

If it was hypothesized that optimization of the heating temperature would be within purview of one skilled in the art, there would still be no teachings that would lead to the Applicants' claimed subject matter, even without any suggestion.

When an appropriate content of Mo is added (as in Claim 1), and the final induction hardening is conducted at a heating temperature of 800-950°C, unexpectedly a fine size of pre-existing austenite grain is obtained as disclosed in Fig. 2. Such a drastic change cannot be expected from the induction heating temperature outside the claimed range or from the study of Mo free steel as shown in that figure. Therefore, conducting the final induction hardening at a heating temperature of 800-950°C with the selected chemical composition is anything but obvious.

Further, the rejection relies upon US '105 at column 12, lines 52 to 67, in rejecting the cooling rate after hot-working of at least 0.2°C/s (page 7 of the Official Action dated July 25, 2007). The disclosed cooling rate would be at best an optimization following carburization hardening, which has already been demonstrated as a totally different technology in terms of austenite grain-size control. One skilled in the art would not look to such a cooling rate for material subjected to induction hardening.

Furthermore, the rejection relies on the alleged "similarity" of heat treatment in US '105 in rejecting the steel product having a structure of bainite and/or martensite and the total volume

fraction of bainite and martensite being 10% or more (page 4 of the Official Action dated July 25, 2007). As already demonstrated, the heat treatment of US '105 is not similar to that of the claimed subject matter. Therefore, the above feature is also not obvious.

Furthermore, the rejection for pre-existing austenite grain size of the hardened layer being 12 μm or less though the thickness of the hardened layer is also relied upon in US '105 (pages 6 to 7 of the Official Action dated July 25, 2007), which is a result of different hardening treatment. Therefore, this feature is also not obvious.

In light of the foregoing, the Applicants respectfully submit that the entire Application is now in condition for allowance, which is respectfully requested.

Respectfully submitted,

T. Daniel Christenbury
Reg. No. 31,750
Attorney for Applicants

TDC/vbm
(215) 656-3381